SJ 71

SCIENTIFIC TIME SHARING CORPORATION

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#3 APL\360 USER'S MANUAL, A. D. Falkoff and K. E. Iverson - IBM Corporation $ 5.00

#4 APL\360 REFERENCE MANUAL, S. Pakin - SRA, 1968 $ 5.00

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(with APL)

SJ 71

```
      )LOAD 1 FILES
SAVED  13.13.18 11/30/70
      'SAMPLEFILE' FCREATE 1      Create file 1 named SAMPLEFILE
      'ALPHA DATA' FAPPEND 1      Place new component on file 1 with character data
      (⍳1000) FAPPEND 1           First 1000  integers become  2nd component of  file 1
      'ABCDEFGHI' FAPPEND 1       Place character data into 3rd component
      (?35 27⍴99999) FAPPEND 1    Array of random data into 4th component
      FREAD 1 1                   Read file 1 component 1
ALPHA DATA
      ¯5↑FREAD 1 2                Take last 5 elements of file 1 component 2
996  997  998  999  1000
      +/FREAD 1 2
500500
      ⍴FREAD 1 4
35  27
      (FREAD 1 4)[26;8 2 14]
43045  76234  51934
      (?12⍴9) FREPLACE 1 1        Replace component 1 with 12 random integers
        FREAD 1 1
 9  1  9  2  9  5  3  7  6  8
        FLIM 1                    What are the limits of file 1?
 1  5                             First component is #1, next to go in will be #5
        FDROP 1 2                 Drop the first 2 components on file 1
        FLIM 1
 3  5                             First component is now #3
        FDROP ¯1  ¯1              Drop the last component
        FLIM 1                    Next to go in will be #4
 3  4
```

REPORT FORMATTING (∆FMT)

```
      NUMERICS
 336067.35       ¯446867.1          7906.35          237.4
 ¯66509               0             223.4          ¯84.556
¯188209.4          8130            1235.6        867552.45

      ALPHA
ITEM1
ITEM2
ITEM3

      ⍝ COMMA INSERTION, ZERO SUPRESSION, FIELD WIDTH OF 20, 2 DECIMAL PLACES

      'CBF20.2' ∆FMT NUMERICS
     336,067.35        ¯446,867.10          7,906.35            237.40
     ¯66,509.00                             223.40            ¯84.56
    ¯188,209.40            8,130.00         1,235.60        867,552.45


      ⍝ COMMA INSERTION, ZERO SUPRESSION, FLOATING DOLLAR SIGN, PARENTHESIZE NEGATIVES
      ⍝ FIELD WIDTH OF 20, 2 DECIMAL PLACES

      'CBP□$ □Q□ □M□(□N□)□F20.2' ∆FMT NUMERICS
      $ 336,067.35       (446,867.10)        $ 7,906.35          $ 237.40
        (66,509.00)                          $ 223.40            (84.56)
      (188,209.40)        $ 8,130.00         $ 1,235.60        $ 867,552.45


      ⍝ ALPHABETIC FIELD, SEPARATORS, SPLIT FIELDS...ONE WITH COMMA INSERTION, ZERO SUPRESSION,
      ⍝ MIDDLE BAR INSERTED FOR NEGATIVES, THE OTHER WITH COMMA INSERTION, FLOATING DOLLAR SIGN,
      ⍝ FOLLOW CREDITS AND DEBITS WITH CR OR DB OVER A FIELD OF 20 WITH 2 DECIMAL PLACES

      '5A1,□ ⍝⍝ □,2CBM□-□I15,2CP□$ □Q□ CR□M□ □N□ DB□F20.2' ∆FMT (ALPHA;NUMERICS)
ITEM1 ⍝⍝          336,067       -446,867       $ 7,906.35 CR          $ 237.40 CR
ITEM2 ⍝⍝          -66,509                      $ 223.40 CR              84.56 DB
ITEM3 ⍝⍝         -188,209          8,130       $ 1,235.60 CR      $ 867,552.45 CR

      ⍝ SAME AS ABOVE BUT WITH A PHRASE INSERTED FOR ZERO OCCURENCES

      '5A1,□ ⍝⍝ □,2CBM□-□R□                NONE□I20,2CP□$ □Q□ CR□M□ □N□ DB□F20.2' ∆FMT (ALPHA;NUMERICS)
ITEM1 ⍝⍝              336,067             -446,867        $ 7,906.35 CR          $ 237.40 CR
ITEM2 ⍝⍝              -66,509                NONE         $ 223.40 CR              84.56 DB
ITEM3 ⍝⍝             -188,209               8,130         $ 1,235.60 CR      $ 867,552.45 CR
```

APL PLUS

EXAMPLES OF USEFUL FUNCTIONS IN APL PLUS

CUMULATIVE SUM

```
      ∇CUMSUM[□]∇
     ∇ R←CUMSUM X
[1]    R←((⍳⍴X)∘.≥⍳⍴X)+.×X
     ∇

    CUMSUM 1 2 3 4 5 6
 1  3  6  10  15  21
```

HYPOTENUSE OF A RIGHT TRIANGLE

```
      ∇HYP[□]∇
     ∇ C←A HYP B
[1]    C←((A*2)+B*2)*0.5
     ∇

     3 HYP 4
 5

     3 1 5 HYP 4 1 12
 5  1.414213562  13
```

SORT CHARACTERS

Any collating sequence may be used.

```
      ∇SORT[□]∇
     ∇ R←COL SORT M
[1]    R←M[⍋(1+⍴COL)⊥⍉COL⍳M;]
     ∇

     CITIES
WASHINGTON
HARTFORD
NEW YORK
PHILADELPHIA
BOSTON
PITTSBURGH
DALLAS
LOS ANGELES
PALO ALTO
SAN FRANCISCO
     ALF←'ABCDEFGHIJKLMNOPQRSTUVWXYZ'
     CITIES←ALF SORT CITIES
     CITIES
BOSTON
DALLAS
HARTFORD
LOS ANGELES
NEW YORK
PALO ALTO
PHILADELPHIA
PITTSBURGH
SAN FRANCISCO
WASHINGTON
```

POLYNOMIAL EVALUATION

Consider polynomial: $Y=3X^4 -9X^3+4X+13$
It's coefficients are: 3 -9 0 4 13

```
      ∇POLY[□]∇
     ∇ R←C POLY X
[1]    R←(((⍴X),1)⍴X)⊥C
     ∇

     C←3 ¯9 0 4 13
     C POLY 1
11
     C POLY 10
21053
     X←2 3⍴1 10,⍳4
     X
 1  10   1
 2   3   4
     C POLY X
 11          21053          11
  3             25         221
```

TABLE LOOK UP

Given a table of character data (CITIES) and a table of possible new entries (NEWCITIES) see if the new entries are already in the table. Try it the other way around.

```
      ∇TLU[□]∇
     ∇ R←T TLU N
[1]    R←(⍳1+⍴T)+.×T∧.=⍉N
     ∇

     NEWCITIES
CHICAGO
BOSTON
HOUSTON
WASHINGTON
     CITIES TLU NEWCITIES
0  1  0  10
     NEWCITIES TLU CITIES
2  0  0  0  0  0  0  0  0  4
```

APL PLUS®

more powerful than FORTRAN

. . . easier than BASIC . . .

DESK CALCULATOR OPERATIONS

```
      82                    User input indented
82                          Response not indented
      2+5                   Add   Scalar to scalar
7
      4-6                   Subtract
¯2
      678×23.4              Multiply
15865.2
      5÷7                   Divide
0.7142857143
      )DIGITS 16            Change display to 16 places
WAS 10
      5÷7
0.7142857142857143          Internal precision is 16+
      )DIGITS 10
WAS 16
```

OPERATIONS EXTEND TO VECTORS

OPERATIONS EXTEND TO ARRAYS

```
      A←'ABCDEFGHIJKL'
      ⍴A                    Shape of A
12
      3 4⍴A                 Reshape A into 3 rows, 4 columns
ABCD
EFGH
IJKL
      B←2 3⍴⍳6
      B
  1  2  3
  4  5  6
      C←4 2 7 1 5 8
      C←2 3⍴C
      C
  4  2  7
  1  5  8
      B+C                   Operation on arrays
  5   4  10                 element-by-element
  5  10  14
      B×C
  4   4  21
  4  25  48
      B=C                   Relational operators <≤=≥>≠
0 1 0
0 1 0
      B>C
0 0 0
1 0 0
      B,C                   Arrays may be catenated
  1  2  3  4  2  7
  4  5  6  1  5  8
      B,[1]C                Catenated in any dimension
```

```
      2+2 4 7 3 2          Scalar to vector
4  6  9  5  4
      2 4 7 3 2+2          Vector to scalar
4  6  9  5  4
      3 4 5+6 7 8          Vector to vector
9  11 13
      345+678              Spaces separate numbers
1023
      Y←2 4 7 3 2          Y is assigned the value
      Y                    of the expression
2  4  7  3  2
      Y×Y
4  16 49 9  4
      2+4+7+3+2
18
      +/2 4 7 3 2
18
      +/Y
18
      ×/Y
336
      ⌈/Y                  Maximum in Y
7
      ⌊/Y                  Minimum in Y
2
      (⌈/Y)-⌊/Y            Range in Y
5
      2↑Y                  Take first 2 elements
2  4
      ¯3↑Y                 Take last 3 elements
7  3  2
      1↓Y                  Drop first element
4  7  3  2
      ¯1↓Y                 Drop last element
2  4  7  3
      ⍳6                   Index generator
1  2  3  4  5  6
```


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```
      1  2  3
      4  5  6
      4  2  7
      1  5  8
      B←⍉B                 Transpose of matrix B
      B
1  4
2  5
3  6
      B+.×C                Matrix product
 8  22  39
13  29  54
18  36  69
      B[2;2]               Parts of arrays may be selected
5
      B[3;1]←0             and changed
M←1 2 ¯3 2 ¯1 2 1 1 ¯1
      M←3 3⍴M              Simultaneous linear equations:
      M                    x+2y-3z=-9
1  2  ¯3                  2x- y+2z=16
2  ¯1 2                   x+ y- z=-1
1  1  ¯1                  solved by dividing vector of constants
      V←¯9 16 ¯1           by matrix of coefficients
      XYZ←V⌹M
      XYZ
4  ¯2 3
      M+.×XYZ
¯9  16  ¯1
```

WRITING PROGRAMS

```
      ∇AVG X               Program defined by typing ∇
[1]   (+/X)÷⍴X             Sum of X divided by shape of X
[2]   ∇                    End program by typing 2nd ∇
      AVG 1 2 3 4          Execute AVG
2.5
      AVG Y
3.6
      ∇CIRCLE              Define program CIRCLE
[1]'WHAT IS THE RADIUS?'   Conversational program
[2]   R←⍞                  R is input
[3]   AREA←3.14×R*2
[4]'THE AREA IS ';AREA
[5]   ∇
      CIRCLE               Execute CIRCLE
WHAT IS THE RADIUS?
⍞:
      4
THE AREA IS 50.24
      CIRCLE
WHAT IS THE RADIUS?
⍞:
      1 2 3 4 5.5
THE AREA IS 3.14           Input can be scalar, vector, or array
      12.56  28.26
      50.24  94.985
```